(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 585 545 B1**

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: **18.10.95**

(51) Int. Cl.[6]: **B29C 43/36**, B29C 70/06, B29K 77/00

(21) Application number: **93109146.6**

(22) Date of filing: **07.06.93**

(54) A breather pad mainly made out of nylon fibers.

(30) Priority: **08.06.92 US 894949**

(43) Date of publication of application:
09.03.94 Bulletin 94/10

(45) Publication of the grant of the patent:
18.10.95 Bulletin 95/42

(84) Designated Contracting States:
BE DE ES FR GB IT NL SE

(56) References cited:
EP-A- 0 318 867
EP-A- 0 358 510
US-A- 4 311 661

AIRTECH INTERNATIONL INC. 'General Information about the sold products "Breathers and bleeders"' 1987 , AIRTECH INTERNATIONAL INC. ,2542 EAST DEL AMO BLVD, CARSON CALIFORNIA 90749 , CALIFORNIA U.S.A.

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to the manufacture of parts, such as, for example, aircraft, boat and automobile panels, embodying resine and/or adhesive materials.

Description of the Prior Art

The curing of shaped composite parts comprising fibers such as graphite or Kevlar fibers impregnated with thermosetting resins or the bonding of thin metallic or metallic and resinous laminates with thermosetting adhesives is recognized as an effective method of manufacturing lightweight, high strength panels, etc.

In carrying out such procedures with composites, the involved part is placed on a shaped tool or mold in an uncured and somewhat pliant state. A relatively high degree of temperature and pressure is then applied thereto to remove air, moisture and volatiles from the material during the forming and curing operation.

In bonding thin laminates of metal or metal and a composite material together, a thermosetting adhesive is sandwiched between them and they are likewise placed on a shaped tool and subjected to a high degree of temperature and pressure to remove the air, volatiles, etc. therefrom during the forming and bonding operation.

The bonding of shaped parts is generally accomplished by placing the materials to be bonded on a shaped tool and covering them with a flexible porous breather pad after which a vacuum bag is placed thereover and scoured to the tool. This assembly is then heated in an autoclave while vacuum is pulled on it to withdraw air and volatiles from the bag and resinous material and from any adhesive present during the curing phase and to impress the part being formed against the tool. The breather pad enables vacuum to be pulled uniformly on all areas of the part and/or the adhesive. The autoclave is pressurized during this procedure to help force the part to intimately fit the contour of the tool and to aid in removing the air, volatiles, etc. therefrom.

Heretofore, breather pads have been formed of intertwined fibers of polyester material and have been generally satisfactory when the curing temperatures were held to little more than about 149 • C (300 • F). However, as composite materials and adhesives of improved strength and other desirable qualities were developed they were found to require higher curing temperatures than this, as well as higher than the conventional forming pressures then employed. This caused the polyester fibers of the breather pad to soften and compact or even fuse together thus closing the interstices between the intertwined fibers and preventing uniform evacuation of volatiles, etc., from all areas of the material being treated as well as any adhesive present. Accordingly, the resulting part instead of being formed into a solid dense structure would tend to contain zones of weakened structural integrity.

SUMMARY OF THE INVENTION

A principal object of the present invention is therefore to provide a breather pad of the above-described type which will withstand higher temperatures and pressures than conventional polyester pads can without significant degradation of its properties.

Another object is to provide such a breather pad which will retain its porosity under significantly higher temperatures and pressures than possible with polyester breather pads.

Still another object is to provide such a breather pad in which the fibers retain their resiliency under higher pressures and temperatures than heretofore possible with polyester pads.

A further object is to provide such a breather pad having a highly uniform porosity throughout.

I have discovered that the use of nylon fibers in lieu of polyester fibers has resulted in an improved breather pad that will withstand considerably greater temperatures and pressures than conventional polyester pads can without significant degradation of the porosity and resiliency of the pad.

I've discovered, also, that certain suitable fibrous materials, such as fiberglass or polyester fibers can be admixed with the nylon fibers without undue loss of temperature or pressure tolerance in the resulting pad. Such mixtures can, for example, include up to 49 percent by weight of the non-nylon fibers.

Tests have shown that my improved breather pad can safely withstand temperatures of at least 230 • C (450 • F) and autoclave pressures of up to 13.8 bar (200 psi) without significant affect on its porosity or resiliency. In this respect, it should be noted that the vicat softening point of nylon, i.e., the point at which it begins to soften, is only 2.75 • C (5 • F) below its melting point of approximately 252 • C (485 • F), whereas polyester has a vicat softening point of approximately 152 • C (305 • F) which makes it unsuitable for working at temperatures of 177 • C (350 • F) or higher.

EP-A-0 318 867, upon which the preamble of claim 1 is based, describes a method and appara-

tus to prevent buckling of thermoplastic composite laminates during an autoclaving process. In this document, it is shown that edge strips are placed around the periphery of the laminate to prevent the vacuum bag of the autoclave from making contact with the edges of the laminate when the autoclave is pressurized. The vacuum bag is then prevented from imparting inwardly directed forces to the edges of the laminate which could otherwise cause this laminate to buckle.

BRIEF DESCRIPTION OF THE DRAWING

The manner in which the above and other objects of the invention are accompanied will be readily understood from the present specification considered in conjunction with the accompanying drawing, wherein:

FIG. 1 is an enlarged cross sectional view, partly broken away, showing an uncured part of composite resinous material mounted on a forming tool and surmounted by my improved breather pad preparatory to a curing operation in an autoclave.

FIG. 2 is an enlarged cross sectional view, partly broken away, of a needle punch for compacting partially compressed nylon fibers into desired breather pad thickness for purposes of this invention.

FIG. 3 is an enlarged cross sectional view, partly broken away, of the compacted fibers from the needle punch operation.

FIG. 4 is an enlarged fragmentary cross sectional view of a part comprising superposed metal sections with a layer of thermosetting adhesive therebetween.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1 of the drawing, a rigid forming tool or mold 11 is shown which may be of metal, fiberglass or other suitably rigid material capable of withstanding relatively high temperatures and having a surface 12 contoured in accordance with the desired shape of a structural part to be formed thereon.

A thin film 13 of a release agent of any well-known type, normally in the form of a liquid or paste having nonadhesive qualities, overlies the tool surface 12. This is surmounted by an uncured part 14 which can be of any suitable thickness. The part 14 is a composite formed from a thermosetting resin and strengthening fibers of graphite, ceramic or like temperature stable material. In its uncured state, the part 14 is pliant and can thus be shaped to fit the contour of the tool surface 12.

A release film 15 having a number of small perforations 16 is fitted over the part 14. This film 15 may be formed of any well-known type having nonadhesive qualities, preferably on the order of 0.013 to 0.05 mm (.0005 to .002 inch) thick.

According to the present invention, a breather pad 116, to be described in detail hereinafter, is placed over the release film 15 and a flexible vacuum bag 17 is mounted over the pad 116. The vacuum bag is forced of a suitably heat-resistant material having a thickness preferably on the order of 0.05 mm to 0.13 mm (.002 to .005 inch). The edges of the bag 17 are sealed to the outer edges of the tool surface 12 by a suitable adhesive sealant tape 20 of any well-known type. Accordingly, the part 14 and breather pad 116 are hermetically sealed from the exterior. A suitable vacuum valve connection 18 connects the interior of the bag 17 through a hose 201 to a suitable vacuum pump or other vacuum source (not shown).

In the curing operation, the assembly of FIG. 1 is placed in an autoclave (not shown). Air is evacuated from under the bag 17 by pulling vacuum there and the autoclave is heated to an appropriate temperature. The autoclave is also pressurized to assist in forcing the part 14 against the tool 11. During this process, while the material of part 14 is curing, all air, moisture and volatiles are forced out of it through the breather pad 116 and vacuum/vent line 201, enabling the part 14 to be void-free, with the desired properties, when cured.

After the curing step is completed, the vacuum bag, breather pad and release film 15 are removed and the finished part is separated from the tool surface.

Alternatively, as shown in FIG. 4, the part may comprise two superposed metal sections or laminates 27 and 28 with a layer 29 of a suitable thermosetting adhesive therebetween. In this case, evacuation of the bag 17 during the bonding step will withdraw air, moisture and volatiles from the adhesive layer 29 at its outer edges 30 to improve the adhesive quality of the layer. It will be noted that the sections 27 and 28 can also be formed of differing materials. For example, one section can be formed of metal and the other formed of a composite material.

FIG. 2 and 3 illustrate a needle punch operation for forming breather pad material in accordance with the present invention. As a first step, resilient nylon fibers 16a are bundled together in random directional orientation to form a bale. These fibers are preferably on the order of 0.013 mm (.0005 inch) in diameter and may be formed from either virgin nylon or scrap nylon. The fibers are preferably from about 50.8 mm (two inches) to about 101.6 mm (four inches) in length. Alternatively, the nylon fibers nay be mixed with up to 49%

by weight of other fibers, such as fiberglass, polyester, or other suitable fibers, to yield a mixture suitable for purposes of the present invention.

In the process of forming the breather pad material of this invention, the bales of nylon, or nylon and other fibers, are shredded, then formed into appropriately thick beds of the fibers which are fed to a needle punch in which arrays of needles 23 with right-angled upper ends 26 are mounted to reciprocate up and down through the fiber bed to thereby intertwine and compact the fibers into appropriate breather pad thickness. See FIG. 2, which illustrates the needle action of the needle punch. FIG. 3 shows an enlarged segment of breather pad material from the needle punch operation. This material can be varied in thickness depending upon the individual requirements of specific curing operations. Individual breather pads are cut from rolls of the material as needed for such operations.

The formation of breather pads from bales of nylon fibers is equivalent to the known method of making breather pads from polyester fibers, and forms no part of the present invention, except insofar as the substitution of nylon fiber material for polyester fiber material is concerned. The actual steps of the needle punch operation itself are so well known as to require no further elaboration here.

In summary, the breather pad of this invention retains its shape during handling and springs back to somewhat the same shape after being compressed at a temperature below its melting point, typically from about 243 °C (470 °F) to about 249 °C (480 °F). It is thus sometimes usable for a number of curing operations, as opposed to polyester breather pads which always lose their resiliency when compressed at curing temperatures.

Typically representative of a nylon breather pad material in accordance with this invention is that available from AIRTECH International, Inc. of Carson, California under the proprietary name Ultrawave. That product has a maximum use temperature of 232 °C (450 °F), and a melting point of 249 °C (480 °F). It in available in various weights and thicknesses. The weight, in kg/m^2 (oz. per square yard), of breather pad material directly affects its thickness. Typical thicknesses of the material can vary from as low as that represented by 0.135 kg/m^2 (4 oz. per square yard) to that represented by 0.85 kg/m^2 (25 oz. per square yard).

Another nylon breather pad product is available from AIRTECH International, Inc. under the proprietary name Nylweave. This product has a maximum use temperature of 204 °C (400 °F) and a melting point of 216 °C (420 °F).

From the foregoing, it will be seen that I have provided a breather pad that will retain its porosity and resilienoy over far greater temperature and pressure ranges than possible with the previously known polyester breather pads. Another advantage of my nylon breather pad over its polyester counterpart is a more uniformly consistent structure than that of the latter, in which some areas are thinner than others.

Claims

1. A breather pad (116) primarily adapted for use in the bonding and/or curing of a part (14) comprising thermosetting composite resinous material or metallic and adhesive materials or a combination thereof in which said part (14) is located between a forming tool (11) and said breather pad (116) and a vacuum bag (17) is hermetically sealed over said breather pad (116) and said part (14) to enable a vacuum to be drawn to evacuate said vacuum bag (17) and remove volatile substances from said part (14) through said breather pad (116) during said bonding and/or curing procedure, characterized in that said breather pad (116) comprises a mass of fibers of nylon forming a resilient porous body.

2. A breather pad as defined in Claim 1 characterized in that said fibers are all of virgin nylon.

3. A breather pad as defined in Claim 1 characterized in that said fibers are a mixture of at least 51 percent nylon fibers, the rest being fibers of a suitable, compatible material.

4. A breather pad as defined in Claim 3 characterized in that the rest of said fibers are fiberglass fibers.

5. A breather pad as defined in Claim 3 characterized in that the rest of said fibers are polyester fibers.

6. A breather pad as defined in Claim 2 characterized in that said fibers are on the order of 0.0127mm (.0005 inch) in cross-sectional diameter.

7. A breather pad as defined in Claim 2 characterized in that said fibers are on the order from 50 to 101mm (2 to 4 inches) in length.

8. A breather pad as defined in Claim 6 characterized in that said fibers are on the order of from 50 to 101mm (2 to 4 inches) in length.

9. A breather pad as defined in Claim 1 characterized in that said fibers are formed from

scrap nylon.

Patentansprüche

1. Entgasungspolster (116) in erster Linie für die Verwendung beim stoffschlüssigen Verbinden und/oder Härten eines Teils (14), der duroplastisches Harz-Verbundmaterial oder metallische Materialien und Klebstoff oder eine Kombination derselben aufweist, wobei der genannte Teil (14) zwischen einem Formwerkzeug (11) und dem Entgasungspolster (116) über dem genannten Teil (14) in dichte Anlage gebracht wird, so daß durch Anlegen eines Vakuums während des Vorganges zum stoffschlüssigen Verbinden und/oder Härten der Vakuumback (17) evakuiert werden kann und flüchtige Substanzen durch das Entgasungspolster (116) hindurch von dem genannten Teil (14) entfernt werden können, dadurch gekennzeichnet, daß das Entgasungspolster (116) eine einen elastischen porösen Körper bildende Masse aus Nylonfasern aufweist.

2. Entgasungspolster nach Anspruch 1, dadurch gekennzeichnet, daß alle Fasern aus jungfräulichem Nylon bestehen.

3. Entgasungspolster nach Anspruch 1, dadurch gekennzeichnet, daß die Fasern Im Gemisch mindestens 51% Nylonfasern enthalten und der Rest aus Fasern aus einem geeigneten kompatiblen Material besteht.

4. Entgasungspolster nach Anspruch 3, dadurch gekennzeichnet, daß die restlichen Fasern Glasfasern sind.

5. Entgasungspolster nach Anspruch 3, dadurch gekennzeichnet, daß die restlichen Fasern Polyesterfasern sind.

6. Entgasungspolster nach Anspruch 2, dadurch gekennzeichnet, daß die Fasern einen Querschnittsdurchmesser in einer Größenordnung von 0,0127 mm haben.

7. Entgasunspolster nach Anspruch 2, dadurch gekennzeichnet, daß die Fasern eine Länge in einer Größenordnung von 50 bis 101 mm haben.

8. Entgasungspolster nach Anspruch 6, dadurch gekennzeichnet, daß die Fasern eine Länge in einer Größenordnung von 50 bis 101 mm haben.

9. Entgasungspolster nach Anspruch 1, dadurch gekennzeichnet, daß die Fasern aus Nylonabfall bestehen.

Revendications

1. Tampon de dégavage (116) principalement adapté pour être utilisé dans la liaison et/ou la polymérisation d'une pièce (14) comprenant une matière résineuse composite thermodurcissable ou des matières métalliques et adhésives ou une combinaison de ces matières dans lequel ladite pièce (14) est située entre un outil de formation (11) et ledit tampon de dégavage (116) et une poche à vide (17) est scellée de façon hermétique sur ledit tampon de dégavage (116) et ladite pièce (14) pour permettre une aspiration par le vide afin de vider ladite poche à vide (17) et retirer les substances volatiles de ladite pièce (14) au travers dudit tampon de dégavage (116) pendant ladite procédure de liaison et/ou de polymérisation, caractérisé en ce que ledit tampon de dégavage (116) comprend une masse de fibres de nylon formant un corps poreux élastique.

2. Tampon de dégavage selon la revendication 1 caractérisé en ce que lesdites fibres sont toutes en nylon vierge.

3. Tampon de dégavage selon la revendication 1, caractérisé en ce que lesdites fibres sont un mélange d'au moins 51 % de fibres de nylon, le reste étant constitué de fibres d'une matière convenable compatible.

4. Tampon de dégavage selon la revendication 3, caractérisé en ce que le reste desdites fibres consiste en fibres de verre.

5. Tampon de dégavage selon la revendication 3, caractérisé en ce que le reste desdites fibres consiste en fibres de polyester.

6. Tampon de dégavage selon la revendication 2, caractérisé en ce que lesdites fibres ont une section transversale d'un diamètre de l'ordre de 0,0127 mm (0,0005 pouce).

7. Tampon de dégavage selon la revendication 2, caractérisé en ce que lesdites fibres ont une longueur de l'ordre de 50 à 101 mm (2 à 4 pouces).

8. Tampon de dégavage selon la revendication 6, caractérisé en ce que lesdites fibres ont une longueur de l'ordre de 50 à 101 mm (2 à 4

pouces).

9. Tampon de dégavage selon la revendication 1 caractérisé en ce que lesdites fibres sont formées de nylon en copeaux.

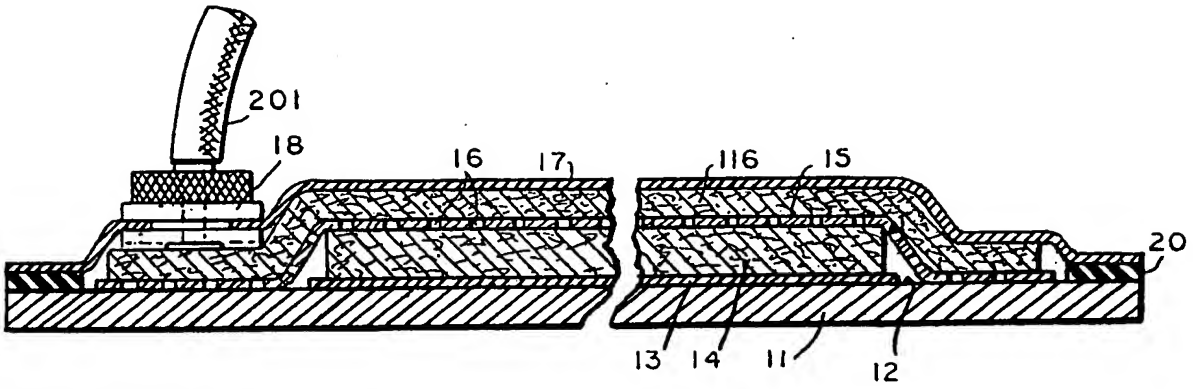

FIG. 1

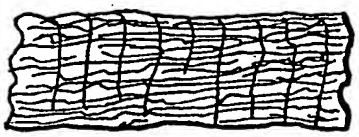

FIG. 3

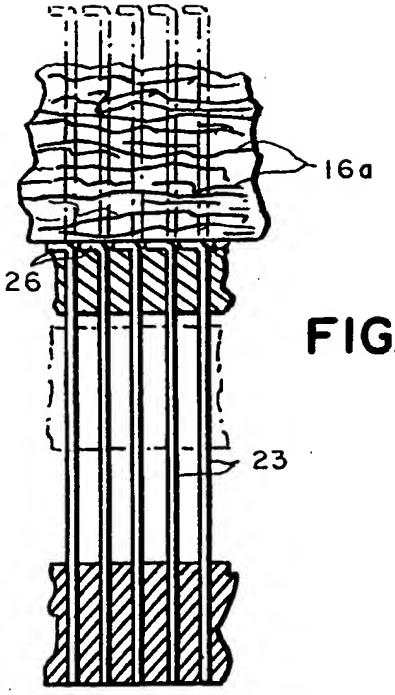

FIG. 2

FIG. 4